It is deemed advisable in the vaccination of school children who are very active on the playground to cover the vaccination with sterile gauze, square, securely fastened with adhesive, with particular care being taken not to encircle the arm. The method used by this department is very rapid. School children are brought to the vaccination table and kept in line; the arm is scrubbed with ether by a nurse; the child is vaccinated by a physician; and the bandage is placed on the arm by the second nurse. Between four and five hundred children may be vaccinated in a forenoon by one physician, with the minimum disruption of class routine.

Out of more than 50,000 vaccinations in which this method was employed, only one case had a severe secondary infection, but with complete recovery and no ill effects.

In conclusion, I wish to state that I prefer the scarification method for group work in preference to all other types of vaccination, and that the single scarification does not produce a scar different from multiple scarification.

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DOCTOR STEVENS (Closing).—A good method that meets the need of the private doctor may not be best suited for the use of a health department in a large city where epidemic and endemic smallpox have to be combated by a rather large number of different vaccinators. Here it is imperative to get immediate takes with safety. Here, too, a uniform method is highly desirable. The only objection is the number of scars. If carefully done, these will not be unsightly. I have had no experience in inserting the vaccine in the scapulary supraspinous region as advocated by Doctor Sippy, but do not see the contraindications that are so apparent when vaccinations are applied to the legs.

FRACTURES OF THE SPINE*

By JAMES T. WATKINS, M. D.
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DISCUSSION *by Rodney F. Atsatt, M. D., Santa Barbara; John C. Wilson, M. D., Los Angeles.*

AT the Lane Library lately, for the purposes of this paper, I looked over the literature for the past ten years dealing with fractures of the spine, uncomplicated by cord injuries. From these reports in English, French and German, and covering well over a thousand fractured spines, it is apparent that such fractures are common injuries; that fully half of them are simple compression fractures; that, except where an x-ray, and notably a lateral x-ray, is employed, they are all too frequently not recognized at the time of injury; that they constitute a heavy burden upon insurance carriers, and therefore, ultimately, upon industry; that if unrecognized, or inadequately treated, they may result in serious impairment of function; that this loss of function is usually not the result of injury to the vertebral body, but is the result of distorted bodily mechanics, *i. e.*, of bad posture and of involuntary efforts at correcting that posture. And this bad posture is the result of change in the mutual relations of the planes of the upper and lower surfaces of the bodies of the injured vertebrae.

In the time at my disposal I cannot possibly cover all types of spinal injury, so I shall confine my remarks to those which compose the majority, actually some 80 per cent, of such fractures.

INCIDENCE

A large majority of such fractures occur in adult males, although since the advent of the automobile, women are increasingly acquiring their quota, at present about 15 per cent. Of these simple compression fractures it is estimated that nearly 80 per cent occur between the eleventh dorsal and second lumbar vertebrae, inclusive; and of these nearly half involve the first lumbar vertebra. These 80 per cent, then, are the subject of this paper.

COMPLICATIONS

These are neurologic symptoms, and fractures of laminae of articular processes of the pedicles and spinous and transverse processes. Aside from the neurologic conditions, fractures of the articular processes are the most troublesome. Finally, injuries elsewhere, notably of the os calcis, may occur; and, in the presence of the graver injury, may be overlooked.

CAUSATION

Any condition or situation which will cause a hyperflexion of the spine, such as blows—actually thrusts—from above and behind, and falls in which the individual lands standing or sitting. Even sudden muscular contractions would appear to be capable of producing compression fractures. Doctor Wesson, who is with us today, sustained such a fracture.

Mechanism.—Crushing of the spongiosa of the anterior portion of the body of one or more vertebrae. I shall not touch on complicating dislocation, though they are probably the result of a diagonal thrust rather than of a simple downward and forward crush.

SYMPTOMS

In an admirable paper by Osgood, one of the many which I consulted in preparing this address, these are divided into early and late symptoms.

Early Symptoms.—At first, these may be masked by those of other fractures or by shock. In a medico-legal case in which I figured lately, with multiple fractures of the extremities, two compressions of the vertebrae were not discovered until nearly a year after the accident. Again, they may be so slight as to escape notice. Of these early symptoms, muscle spasm, with localized limitation of back motion, is *always* present. Tenderness to direct pressure over the spinous processes of the injured vertebrae is *almost* always present. Pain, definitely localized, may be present, but is sometimes absent. In all the cases that I have seen, there has invariably been a fairly localized feeling of weakness, however, even when actual pain was absent. Finally, very frequently marked distention of the abdomen may be a distressing symptom.[1]

* Read at the twenty-ninth annual meeting of the Nevada State Medical Association, Reno, Nevada, September 23-24, 1932.

1 In the discussion elicited by this paper, Doctor Holcomb of Oakland directed attention to this very distressing abdominal distension which frequently accompanies spinal fractures, which I had included in my notes but failed to mention.

Late Symptoms.—Many years ago (on July 3, 1893, I think), Kümmel reported to the surgical society of Hamburg what he believed to be a rarefying osteitis of the spine (of traumatic origin) which presented three stages: (1) A stage of acute injury; (2) a stage of apparent convalescence; and (3) a stage in which there was a slowly developing kyphos and pain in the distribution of the nerves emerging from the spinal foramina at the site of injury. I recall this observation: Die Behandlung ist eine sehr dankbare—"The treatment is very gratifying." He got his patients well with plaster of paris jackets. This occurred in the year before Roentgen of Würzburg discovered the x-ray, and many years before lateral spinal pictures had become possible. I believe Kümmel was reporting what was really a series of unrecognized compression fractures; I have never seen a definite pathologic entity such as Kümmel, basing his opinion on his clinical findings, described.

DIAGNOSIS

"The key to diagnosis is suspicion." Every patient who has been forcibly doubled up, who has fallen a great distance, landing on his feet or on his buttocks, has a broken back until you have proved that he has not.

TREATMENT

Except in the matter of the Kümmel spine, where I am afraid I stand alone, there is no material divergence of opinion from what I have said among the many authorities I have consulted. In the matter of treatment, however, there is no such thing as unanimity of opinion. On the extremely conservative end we find surgeons who place their patients on firm beds, massage the back musculature, beginning with the fourth day following the accident; sit the patients up at the end of four weeks, and get them out of bed at the end of eight weeks. They never use plaster jackets nor braces. The number and excellence of the results they report is impressive. At the extreme of the swing of the pendulum to its radical end, we find surgeons who regularly fuse every spinal fracture. They are satisfied with their results, or they would not do it; but, on the other hand, in reviewing operative results, we find Eikenbarry of Seattle, who, among 128 claimants who had been subjected to spinal fusion, did not find one who had returned to his original occupation; and Gray of the Aetna Company, who had not seen a single individual whose spine had been subjected to operation who had not become a "life pensioner."

How can we explain these diametrically opposed methods of treatment employed by able and just men who are so convinced they are right that they make permanent record of their procedures and of their results? It must be that one or the other group, or both, lacks the faculty of judicially reviewing its own work. It must be that either one group or both are open to the criticism voiced by Sir James MacKenzie: that for them "a lack of guiding principles is responsible for (many) haphazard methods, and the result is, too often, that, though immense energy is expended, achievement is not commensurate with this 'expense.'"

Are there then any guiding principles applicable to the treatment of uncomplicated spinal fractures? I believe there are, and I further believe that they are the same broad, now universally accepted, principles which apply to the treatment of fractures elsewhere in the body. Let us try to enumerate them.

First, following any fracture of any bone, we bring the fractured ends into alignment and apposition and immobilize them.

Second, if a fracture enters into a joint, other things being equal, we immobilize that joint in that position most difficult for it in health to assume: abduction and elevation at the shoulder, full flexion at the elbow, full supination at the ankle, abduction and internal rotation at the hip, and so on. The knee would seem to be an exception to this rule.

Third, if a bone is impacted (a Colles's at the wrist, a femoral neck, or the upper end of the humerus), other things being equal, we disimpact it and then proceed in the usual way.

Fourth, if there is danger of ankylosis of a fractured joint, we immobilize in that position which will give a maximum of function should the ankylosis become a fact. Now, if these fundamental or basic principles of treatment are true of all other bones and joints, they should be equally true of the multiple bones and joints which, in their totality constitute the spinal column; bones which, because of their cancelous structure ought, *a priori,* to heal quickly and which, as a matter of fact, do heal quickly if given favorable opportunity to do so. The application to fractures of the spine of these fundamental principles underlying all bone setting constitutes my idea of proper treatment.

We noted, a moment ago, that aside from occasional nerve-root pains, the disability following a healed spinal fracture lies, not in the fracture itself, but in the uninjured portions of the column in which, in order to counterbalance the distortion caused by the cave-in of the anterior portion of a vertebra, compensatory curves are developed.

The reasons for these pains are found in the constriction of the vertebrae themselves, and notably in their articular and spinous processes. For, while they have the general configuration given in the descriptive anatomies, a more detailed study of vertebrae of a number of spinal columns will show that their articulations and processes apparently present endless individual variations in length, in pitch, in direction, etc. Indeed, I think it might be said that, just as our faces differ in detail, so, when we study them long enough, our spinal columns equally differ. But, while the still plastic spine of the growing child would seem to be capable of a considerable degree of accommodative readjustment, the same observation would not hold equally good of the spine which had attained to maturity. Nor, by the wildest stretch of the imagination, could Wolff's law be made to apply to the matter in hand.

Consequently, when by reason of the collapse of the front part of, say the second lumbar vertebra, the vertebrae above and below it meet at an angle of perhaps forty-five degrees, the compensatory lordosis above and below the fracture results in the body weight being removed in large part from the intervertebral disks, where it belongs; and transferred back to the articulations, laminae and spines, with resultant multiple sprains and ultimate chronic traumatic arthritis. The problem is even more complex than that; but what I have said is enough to indicate that to leave such a spine in that condition is to court grave disability.

But, to revert for a moment to the two extremes of treatment, I do not see, on the one hand, how the synostosing by operation of a few vertebral spines meets the mechanical problem involved; any more than, on the other hand, letting the patient with a deformed spine lie in bed till he is ready to get up, meets it. I believe we should follow the four cardinal principles of treatment already enunciated: that we should disimpact, remove the deforming factor of weight bearing, and maintain the posture most difficult in health to assume; which, in this case, is the posture in which, should ankylosis supervene, a maximum of function will be retained. This may be accomplished in several ways. Dr. John Dunlop of Pasadena places his patients prone, and practically "tosses them in a blanket." He reports an impressive list of cures. Doctor Rogers of Boston has devised a form of bed upon which the patients lie supine in hyperextension. By means of an attachment, a direct upward (that is corrective) thrust is exerted upon the kyphos and gradually increased till the latter is obliterated. Some years ago I tried to do the same thing with kyphosis secondary to tuberculosis; but I gave it up because the skin gave way before the kyphosis did.[3]

An objection, which, so far as I know, is hypothetical, has been made to the direct attack on the kyphos on the ground that an unrecognized fracture of a lamina, if pressed upon, might result in a fragment of bone being forced into the spinal canal. In view of the firm ligamentous anchors above and below such a lamina, such an argument does not impress me. However, it may be guarded against by taking 67½ degree lateral pictures of the spine; these throw the pedicles, laminae and articulations directly upon the plate, making injuries of them as easy to recognize as similar injuries elsewhere. I have nothing to say against other methods of procedure; but my personal predilection is for the immediate correction of the kyphos. Instead of Doctor Dunlop's blanket tossing, I place the patient prone upon two padded boxes, while assistants make moderate traction on head, arms, and legs. Then, astride of the patient, with my arms held stiffly, I place my hands at either side of the kyphos and, bending my knees, I gradually force the spine into hyperextension till I get a distinct crunch: I feel it and I hear it. My kyphos is then completely gone; I leave no trace of it. I know from my x-ray that my laminae are intact, and I could not push them in anyhow because my thrust is not exerted directly upon the laminae. Without moving the patient, I now pad generously, and over it apply the longest plaster of paris jacket I can, and fill in the hollows with reduplications of plaster of paris bandage. I have never carried the cast down to the knees, though I have read that I should do so.

3 In the discussion, Doctor Holcomb of Oakland advocated making traction on head and feet and, at the same time, exerting an upward lift on the kyphos by means of a flannel bandage passed beneath it and up over the longitudinal bars of a Balkan frame.

AFTER-CARE

If there are no contraindications, beginning with the sixth day, I bivalve the cast, remove the posterior half, and try to anticipate muscle atrophy with massage and baking. If spots of tenderness are noted, after covering the skin with paraffin oil, they are carefully palpated to determine their nature. Should there prove to be sensitive pencil-like indurations in the course of the muscle fibers (the Muskelhärtungen of the Germans) they are worked on with increasing vigor until they disappear. And as soon as soreness has subsided I advise supervised efforts at contracting the back musculature. I feel very strongly that our efforts should be directed toward preventing the atrophy of disuse, rather than toward relieving it once we have allowed it to occur.

I have heard of cases where vertebral distortions which had been corrected had recurred. I believe this was to be attributed (1) to failure to care for the back muscles—the natural braces of the vertebral column—and (2) to allowing patients to sit up; a sitting patient, jacket or no jacket, flattens his lumbar spine. To verify this, apply a packet, cut a hole in it, and watch what happens when the patient sits down: flattening the lumbar spine throws the body weight forward upon the still ununited portion of the vertebral body.

By the time such a person is ready to stand up, he has a firm musculature and is habituated to a correct posture. In the early stages of convalescence, recumbency, with the spine supported in the posture it would assume while standing erect, is indicated. After eight weeks of such recumbency the patient may be got up, standing or walking around for short but gradually increasing intervals of time. Only after the sixteenth week should he be permitted to sit with a flat back.

CONCERNING SUPPORTS

I believe that as we come to recognize and to perfect the technique based upon the principles of treatment here set forth, we will more and more get away from external supports of any sort. The more intelligent and coöperative the patient, the greater will be our success in employing the nonbrace, noncast treatment, as some of the Germans are doing now. Thus far I have not had the courage wholly to do without them myself. If one is going to use an external support, the brace affords much better fixation of the spine

than does the plaster of Paris or similar jacket; but by reason of the direct pressure it exerts, it is correspondingly more mischievous in its effect on the erector musculature.

CONCERNING THE INDICATIONS FOR OPERATION

In the fresh spinal fracture where there is an increasing paralysis, straighten the spine and decompress by doing a laminectomy; but do not open the dura. In an old unrecognized or inadequately treated case with nerve root symptoms and possibly fractured articular facets, but without a generally disseminated arthritis, synostose the damaged vertebra to the uninjured vertebrae immediately above and immediately below it. To do more than this implies still further limiting the motion in a spine whose motion is already unduly limited.

THE TIME OF DISABILITY

In an uncomplicated case this should not be more than six months. I had one synostosed patient back at work, wearing a jacket, at the end of six weeks. Actually, our industrial cases average a year and a half. The late Doctor Hibbs wrote me that in adults synostosing operations should be followed by six to nine months' brace treatment, and that children took from nine months to a year.

Until comparatively lately I had adhered to the radical or operative school. The failure of patients to declare themselves relieved of their disabilities I interpreted to be one of the evils inseparable from compensation insurance. I now incline to hope that a more rational treatment will give a quicker and more nearly complete return to normal.

Medical Building, Hyde and Bush Streets.

DISCUSSION

Rodney F. Atsatt, M. D. (1421 State Street, Santa Barbara).—Doctor Watkin's paper on fractured spines brings out a viewpoint with which I am fully in accord, namely, that it is possible to treat fractured spines by a noncast, nonbrace procedure and have them well and walking and in no danger of recurrence in a much shorter time than is possible with the brace treatment. I personally have treated forty fractures in various portions of the spinal column in the following manner:

The patient is placed on a hyperextension bed, somewhat modified from that described by Doctor Rogers, for a period of eight to ten weeks; active exercises for the arms, legs, and back are begun at the end of the fourth week, though simple anterior tibial and quadriceps setting exercises may have started at once. During the period from four to eight weeks the strenuousness of the hyperextension exercises is increased, until at the end of eight to ten weeks the patient is able to stand and walk with strong, corded erector spinae muscles which act as the body's most efficient brace. I am very glad to hear someone else advocate this form of treatment, as opposed to the more radical procedures. I should like to agree with Doctor Holcomb that there is very apt to supervene, in fractures of the lower dorsal and lumbar spine, a very distressing paralytic ileus which is often difficult to relieve but can sometimes be helped by pilocarpin and eserin.

John C. Wilson, M. D. (1136 West Sixth Street, Los Angeles).—During the past decade the great amount of careful investigation carried on abroad and in this country has led to a better understanding of the anatomy, physiology and pathological physiology of the spinal column as a functional mechanism, and has led to the evolution of a rational treatment of spinal injuries.

Goldthwaite many years ago called attention to the importance of posture in body mechanics and has repeatedly given a clear exposition of this subject. Schmorl's investigations and careful studies of the nucleus pulposus, its expansile properties and relationship to spinal mechanics; Davis' investigation of the strength of the anterior spinal ligaments, the escape of these structures from injuries in compression fractures of the spine and the absolute protection which they afford against excessive hyperextension even though the vertebral bodies adjacent to them are crushed, have led to an entirely new concept in the treatment of compression fractures of the spine.

Less than ten years ago the question which always arose in the treatment of a spinal compression fracture was whether a fusion operation should be done or the injured vertebrae should be allowed to heal through simple immobilization in the position of deformity. Everyone who has had experience through this era of treatment can well remember the results which seemed to be the same regardless of the choice of treatment. Whether operative fixation was or was not done, the patient in the majority of cases complained of weakness and backache. In retrospect, better results could not be expected from a system of treatment which ignored the physiology of the spinal column as a whole; took no consideration of the nature of the fracture and dismissed the subject of body mechanics regarding the injured as a victim of a terrible calamity which nature must repair without assistance.

With the realization that (1) compression fractures of the vertebral bodies are impacted fractures, (2) that impaction of two or more vertebral bodies alters the physiological curve in whatever region of the spinal column it may occur, (3) that an altered curve in any region of the spine interferes with general body mechanics and must be compensated for elsewhere, (4) that impacted vertebral bodies may be disimpacted and the normal or a nearly normal contour restored by hyperextension, (5) that the anterior spinal ligaments afford protection against excessive hyperextension, it becomes clear that any adequate treatment of compression fractures of the spine, as Doctor Watkin's has emphasized, must produce an anatomical restoration of contour, maintain this restoration until healing has resulted and then restore as nearly a normal range of motion as is possible to the entire spinal column and normal musculature to support it.

The armamentarium used to accomplish this; whether it be at one sitting, as advocated by Davis and by Dunlap, or is carried over a period of days, as advocated by Rogers, is a matter for the individual surgeon to decide.

The recognition of the failure of any treatment which accepts a gross distortion of the physiological contour of the spinal column and the fixation of this deformity is a real advance in therapy. With the newer forms of treatment the injured can look for a return to active life with a minimum of residual pain.

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Doctor Watkins (Closing).—I have to thank the gentlemen who discussed my paper for their expressions of approbation. I had expected to have to defend my position; but am pleasantly surprised to learn that, except in minor details, we are all agreed as to the proper treatment of uncomplicated spinal fractures.